MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2016/2017

PCM0035 – GENERAL CHEMISTRY / PCM0016 – CHEMISTRY

(All sections / Groups)

12 OCTOBER 2016
9.00 a.m – 11.00 a.m
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of 4 pages only excluding the cover page.
2. Attempt **ALL** questions. Distribution of the marks for each question is given.
3. Please write all your answers in the answer booklet provided.

QUESTION 1 [20 MARKS]

(a) In one experiment, 92.0 g of phosphorus and 4.9 mol of iodine is allowed to react according to the following chemical equation: $P\ (s) + I_2\ (s) \rightarrow PI_3\ (s)$
[Atomic mass: P = 31.0; I = 127.0]

Answer the following questions:
(i) Write the balanced equation of the reaction. [1 mark]
(ii) Determine the reagent that is used up in the experiment. [2 marks]
(iii) Find the mass of excess reagent (in grams) after the reaction is complete. [1 mark]
(iv) In a laboratory, the production of $PI_3\ (s)$ is 67% - 73% efficient depending on various factors. Calculate the range of mass of the product produced. [2.5 marks]

(b) Large beds of rocks are used in some green homes to store heat. Answer the following:
[Specific heat of rocks: 0.82 $Jg^{-1}K^{-1}$]
(i) Calculate the heat absorbed by 45 kg of rocks if their temperature increases by 12 °C. [1 mark]
(ii) What temperature change would these rocks undergo if they emitted 410 kJ of heat? [1 mark]

(c) The production of $C_2H_2\ (g)$ follows this equation: $2C\ (s) + H_2\ (g) \rightarrow C_2H_2\ (g)$
Given the following thermochemical equations:

$C_2H_2\ (g) + (5/2)O_2\ (g) \rightarrow 2CO_2\ (g) + H_2O\ (l)$	$\Delta H° = -1299.5$ kJ
$C\ (s) + O_2\ (g) \rightarrow CO_2\ (g)$	$\Delta H° = -393.5$ kJ
$H_2\ (g) + (1/2)O_2\ (g) \rightarrow H_2O\ (l)$	$\Delta H° = -285.8$ kJ

Calculate the enthalpy:
[Atomic mass: C = 12.0; H = 1.0]
(i) for the production of $C_2H_2(g)$. [2.5 marks]
(ii) per gram of $C_2H_2(g)$ produced. [1 mark]

(d) An amount of an ideal gas at 290 K has a volume of 17 L at a pressure of 1.2 atm. Find the pressure of the gas sample when the volume is halved and the absolute temperature is multiplied by four.
[R = 0.0821 L·atm/K·mol] [2 marks]

(e) An ideal gas at 8 °C is in a flexible spherical container having a radius of 2.23 cm. The gas is heated at constant pressure to 34.0 °C. Determine the radius of the flexible spherical container after the gas is heated.
[Volume of a sphere = $(4/3)\pi r^3$] [2.5 marks]

(f) Explain the relationship between density and molar mass. Write down the relevant formulae to support your answer. [1.5 marks]

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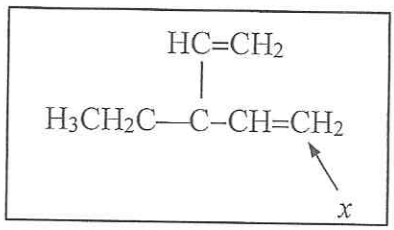
(g) For the following compound:



(i) Predict the correct hybridization for the carbon atom, *x*. [1 mark]
(ii) State the number of sigma (σ) bonds and pi (π) bonds in the molecule. [1 mark]

QUESTION 2 [20 MARKS]

(a) Based on the trends across period 3 of the periodic table, answer the following:
(i) Discuss the nuclear charge of elements across the period. [1 mark]
(ii) Name the element with the highest ionization energy. Explain. [1 mark]

(b) Across a period, electronegativity increases. Based on the statement, answer the following:
(i) Explain the meaning of electronegativity. [1 mark]
(ii) State what the most electronegative element in the periodic table is. Explain your answer. [1 mark]
(iii) To discuss electronegativity, why do we have to ignore noble gas elements? [1 mark]

(c) Give the name and rank the following electrons, shown in the table below, in the order of increasing energy (from lowest to highest): [3 marks]

Electron	Quantum No.
w	(5 , 1 , 0 , ½)
x	(3 , 2 , 2 , -½)
y	(4 , 3 , 1 , ½)
z	(4 , 0 , 0 , -½)

(d) Consider the following reaction at a particular temperature:

$$NO_2\,(g) + N_2O\,(g) \rightleftharpoons 3\,NO\,(g)$$

Given that the equilibrium concentrations are $[NO_2] = 3.50$ M, $[N_2O] = 5.90$ M and $[NO] = 0.4$ M,
(i) What is the value of the equilibrium constant, K_c? [1.5 marks]
(ii) If $[N_2O]$ is removed from the system at equilibrium, what happens to the concentration of NO? [0.5 mark]
(iii) If the process is endothermic, towards which direction will the reaction favour? Explain your answer. [1 mark]

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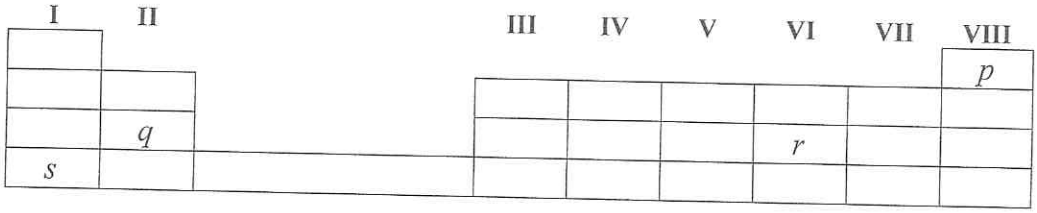
(e) Copper is a chemical element with atomic number 29.
(i) Draw the orbital diagram for copper without using a noble gas core. [1 mark]
(ii) State the number of unpaired electron that copper has. [0.5 mark]

(f) The diagram below shows part of the Periodic Table. Answer the questions that follow.



(i) Rank elements p, q, r and s in order of decreasing atomic size (from highest to lowest). [1 mark]
(ii) Rank these ions in order of decreasing ionic radius: q^+, q and q^-. [1 mark]

(g) Decomposition of dinitrogen pentoxide happens according to the following equation:

$$2N_2O_5\,(g) \longrightarrow 4NO_2\,(g) + O_2\,(g)$$

At t = x, the formation rate of NO_2 is 0.02 M/s. Determine the formation rate of O_2 at t = x. [1.5 marks]

(h) The half-life for the first order reaction below is 20 minutes.

$$B \longrightarrow \text{products}$$

Calculate the rate constant, k and the time needed for the original amount of B to drop to become 20% of its original amount. [2.5 marks]

(i) In a study, the following results are obtained for reaction: $M + N \longrightarrow P + Q$.

Experiment	[M]	[N]	Initial rate of reaction (M/s)
1	$2x$	y	z
2	$2x$	$2y$	z
3	$6x$	$4y$	$9z$

(i) Calculate the overall order of the reaction. [1 mark]
(ii) Find the unit for the rate constant, k. [0.5 mark]

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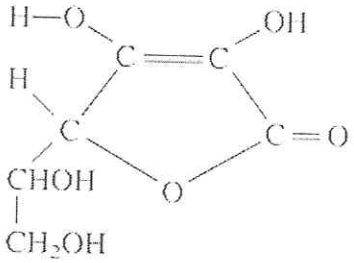
QUESTION 3 [20 MARKS]

(a) A 0.23 M solution of a weak acid, HX, has a pH of 5.72.
(i) Write an expression for the acid dissociation constant, K_a, for the acid. [1 mark]
(ii) Calculate the value of K_a for this acid. [2 marks]

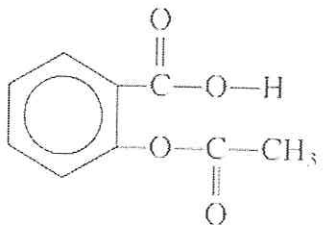
(b) For the reaction below, indicate the Brønsted-Lowry acid and conjugate base.
$H_3O^+(aq) + HSO_4^-(aq) \rightleftharpoons H_2SO_4(aq) + H_2O^-(l)$ [1 mark]

(c) Determine the concentration of OH^- ion at 25 °C for each solution below and determine whether it is acidic, basic or neutral.
(i) $[H^+] = 4.9 \times 10^{-4}$ M [1.5 marks]
(ii) $[H^+] = 0.8 \times 10^{-7}$ M [1.5 marks]

(d) The structures of acetylsalicylic and ascorbic acid are shown below. Identify the acid that would have weaker acid strength. Justify your answer. [2 marks]



Ascorbic ($K_a = 8.0 \times 10^{-5}$)



Acetylsalicylic ($K_a = 3.0 \times 10^{-4}$)

(e) Given that the K_a of formic acid is 1.7×10^{-4}. Find the pH of 0.50 *M* formic acid (HCOOH) solution. [3 marks]

(f) Calculate how many grams of KOH is needed to prepare a 350 mL solution with pH 8.5. [Atomic mass: K = 39; O = 16; H = 1] [2 marks]

(g) Calculate the number of grams of aluminium deposited in an hour by the electrolysis of molten $AlCl_3$ by a constant current of 12 A.
[Atomic mass: Al = 27; Faraday constant = 96500 C/mol e^-] [2 marks]

(h) A voltaic cell with a copper bar and a zinc bar are immersed in $CuSO_4$ solution and $ZnSO_4$ solution respectively. A KCl salt bridge is used to connect both half cells.
(i) Write the half-reactions and the net reaction for the electrolysis. [2.5 marks]
(ii) Explain the function of salt bridge and state the requirement of the selection for the solution in the bridge. [1.5 marks]

End of Paper